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U.S. Army Research, Development and Engineering Command

Maximizing Performance With HSI/MANPRINT & Soldier Survivability

ARL

2014 DoD HFE TAG Theme : *Collaboration among agencies and HSI domains to maximize performance*

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Rich Zigler
POC for Soldier Survivability Domain
General Engineer
U.S. Army Research Laboratory

21 MAY 2014

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Topics

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- **Maximizing HSI/MANPRINT within the Acquisition Process**
- **Soldier Survivability examples encountered in recent years**
- **Collaborations with Organizations**

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Odds of One's Contributions Affecting The Soldier/Marine/SpecOps

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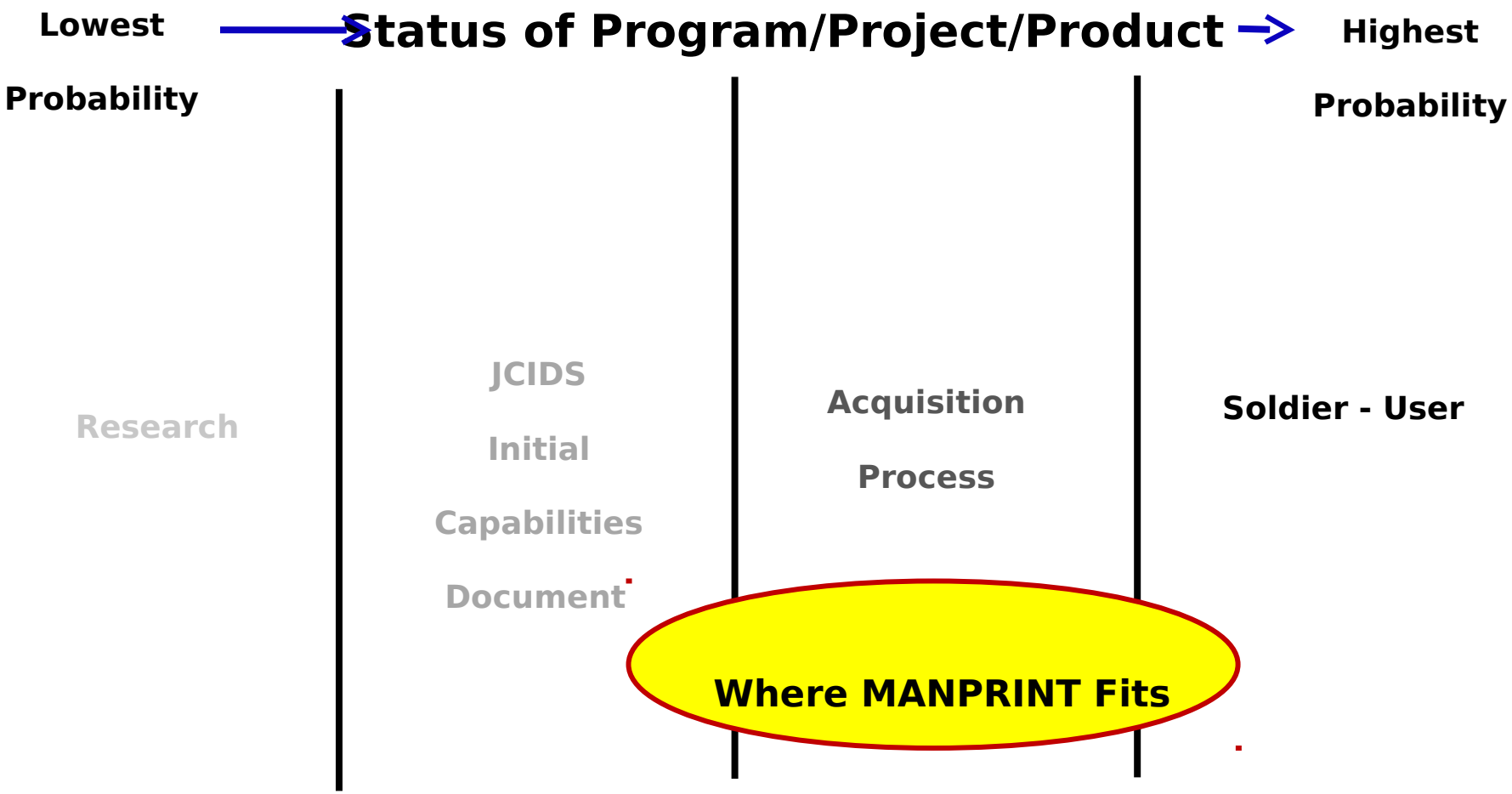

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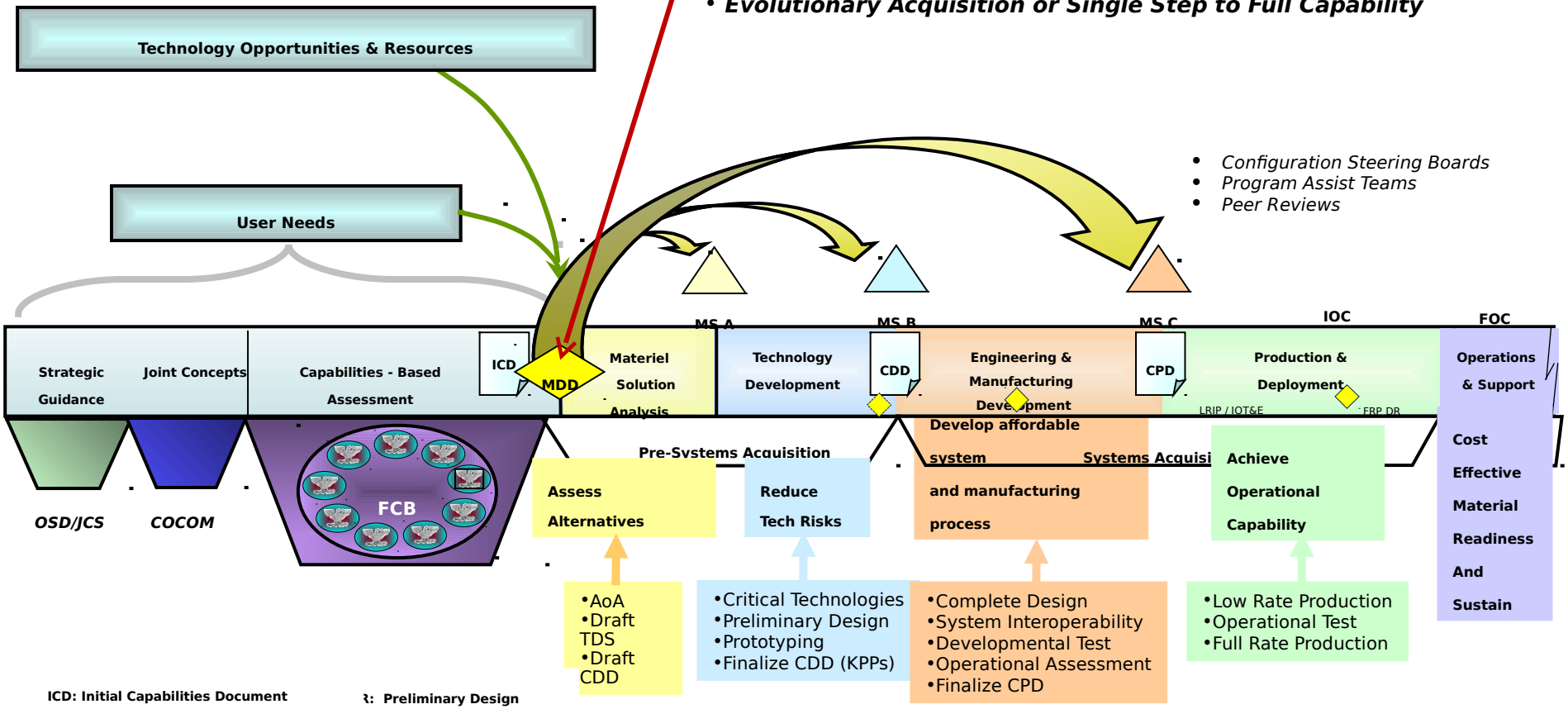
The Defense Acquisition Management Framework

ARL

- ***Materiel Development Decision precedes entry into any phase of the acquisition framework***
- ***Entrance criteria met before entering phase***
- ***Evolutionary Acquisition or Single Step to Full Capability***



ICD: Initial Capabilities Document
CDD: Capabilities Development Document
CPD: Capabilities Production Document
AOA: Analysis of Alternatives
TDS: Technology Development Strategy
KPP: Key Performance Parameters*
FCB: Functional Capabilities Board

R: Preliminary Design
iew
R: Critical Design Review
P: Full Rate Production
: Initial Operational
ability
: Full Operational

Basis: Slide Obtained From Briefing by DAU's Mr. Dillon, modified by Mr.

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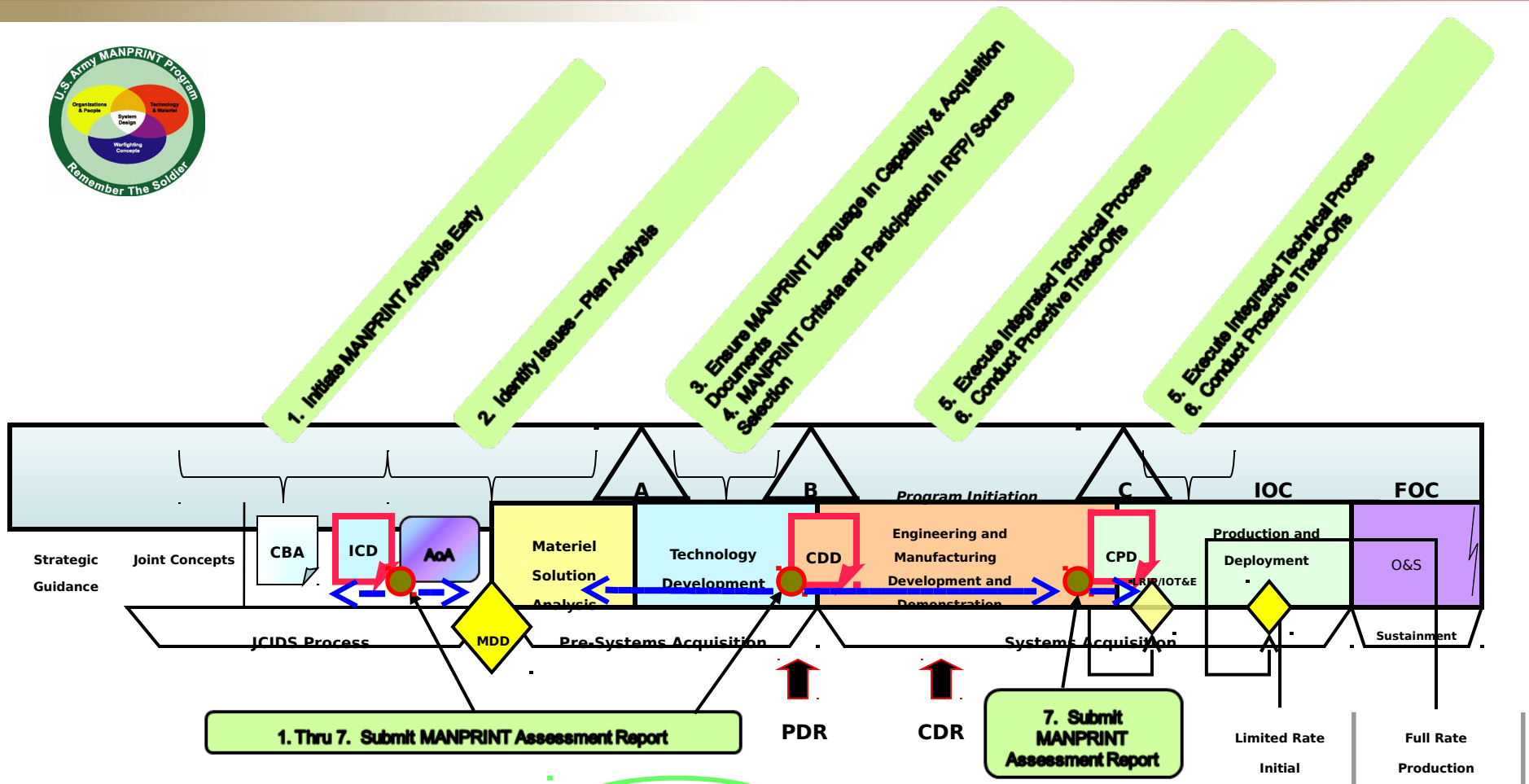
Defense Acquisition Management System

Life Cycle &

ARL



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CDD: Capabilities Development Document

CPD: Capabilities Production Document

AOA: Analysis of Alternatives

CBA: Capabilities-Based Assessment

PDR: Preliminary Design Review

CDR: Critical Design Review

MDD: Materiel Development Decision

IOT&E: Initial Operational Test & Evaluation

LRIP: Limited-Rate Initial Production

O&S: Operation & Sustainment

= Generate & Resolve MANPRINT Issues (G&R or GRI)

= MANPRINT Assessment Report

= Decision Point

= Milestone Review

Basic Slide Obtained From Briefing by Dr. Drillings of G-1 MANPRINT Directorate, modified by Mr. Zigler

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HSI/MANPRINT's Ability to Influence Life Cycle Cost

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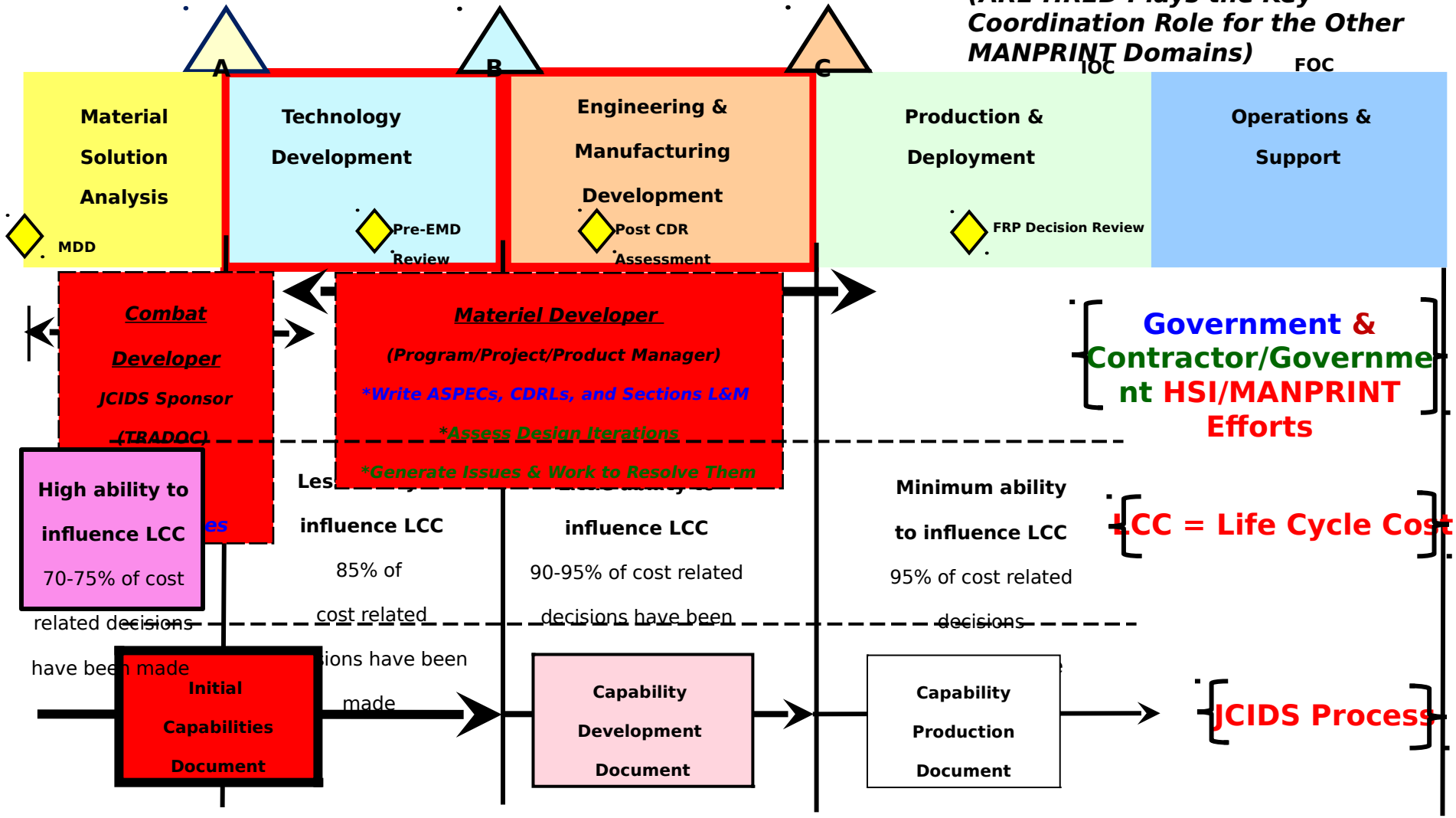
= Greatest Potential

(ARL-HRED Plays the Key Coordination Role for the Other MANPRINT Domains)



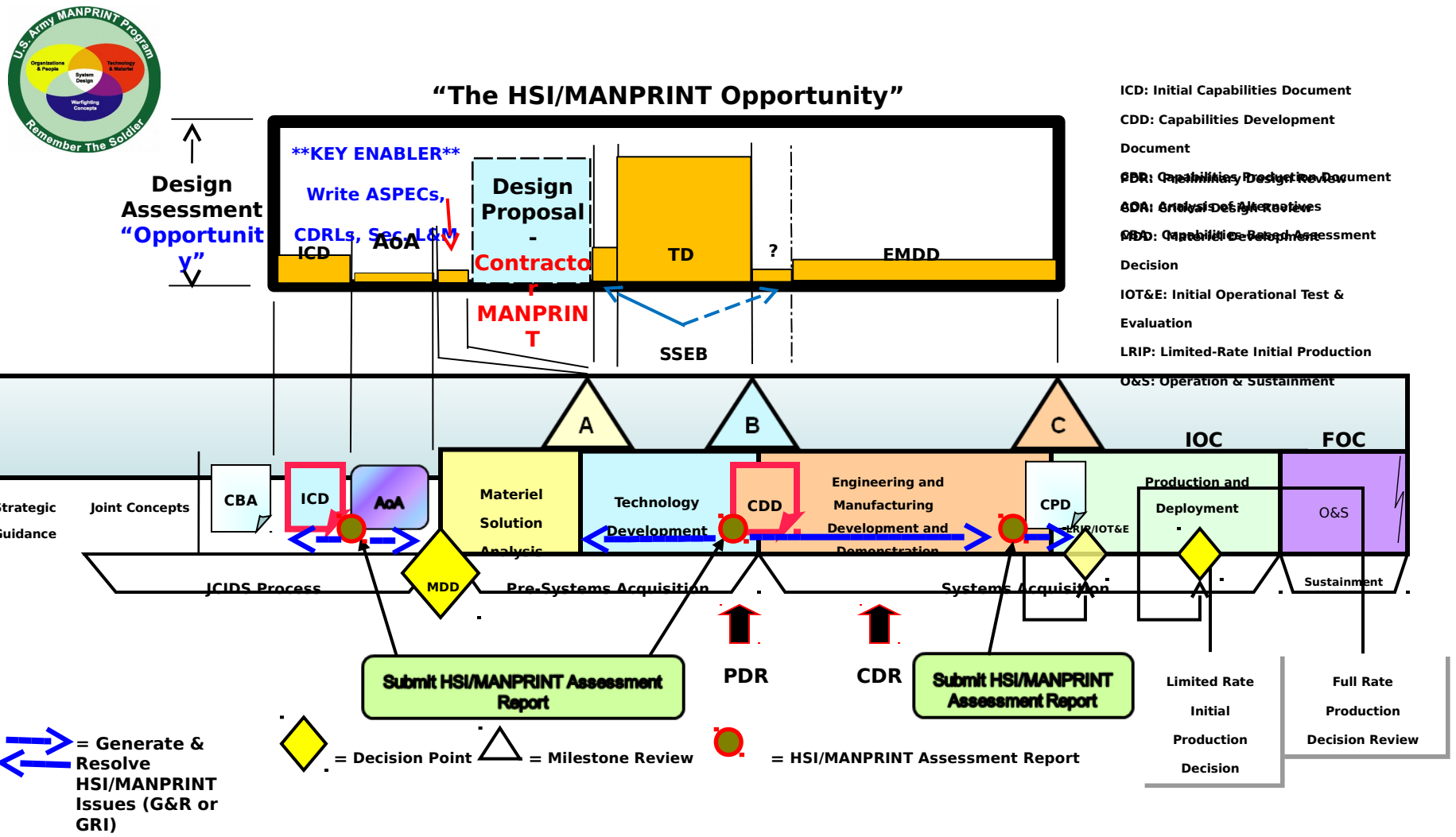
Acquisition Phases – A Key Action

<u>Acquisition Specifications, CDRL's, Sections L&M</u> – Writing; Staffing/Comments; Grow Working Relationships with TRADOC and then with PMO

- Critical areas MANPRINT needs to impact - to affect a program
- Written specifications incorporating MANPRINT principles, and the CDRL's and Sections L&M must back up the specifications. Must be done **<u>TO ENABLE</u>** the government's MANPRINT representatives to have leverage and power to influence the program's design(s).
- Embedded in the contract at the very beginning as the PM will not add things back into the contract due to cost to change the contract.
- ASPECs need to be specific, concrete and testable to be enforced, not just one vague statement about MIL-STD-1472 Rev. G (DoD Design Criteria Standard: Human Engineering), although that should also be there to cover unexpected design issues.

--***Cheryl Burns***, *Fort Knox Field Element, ARL-HRED*

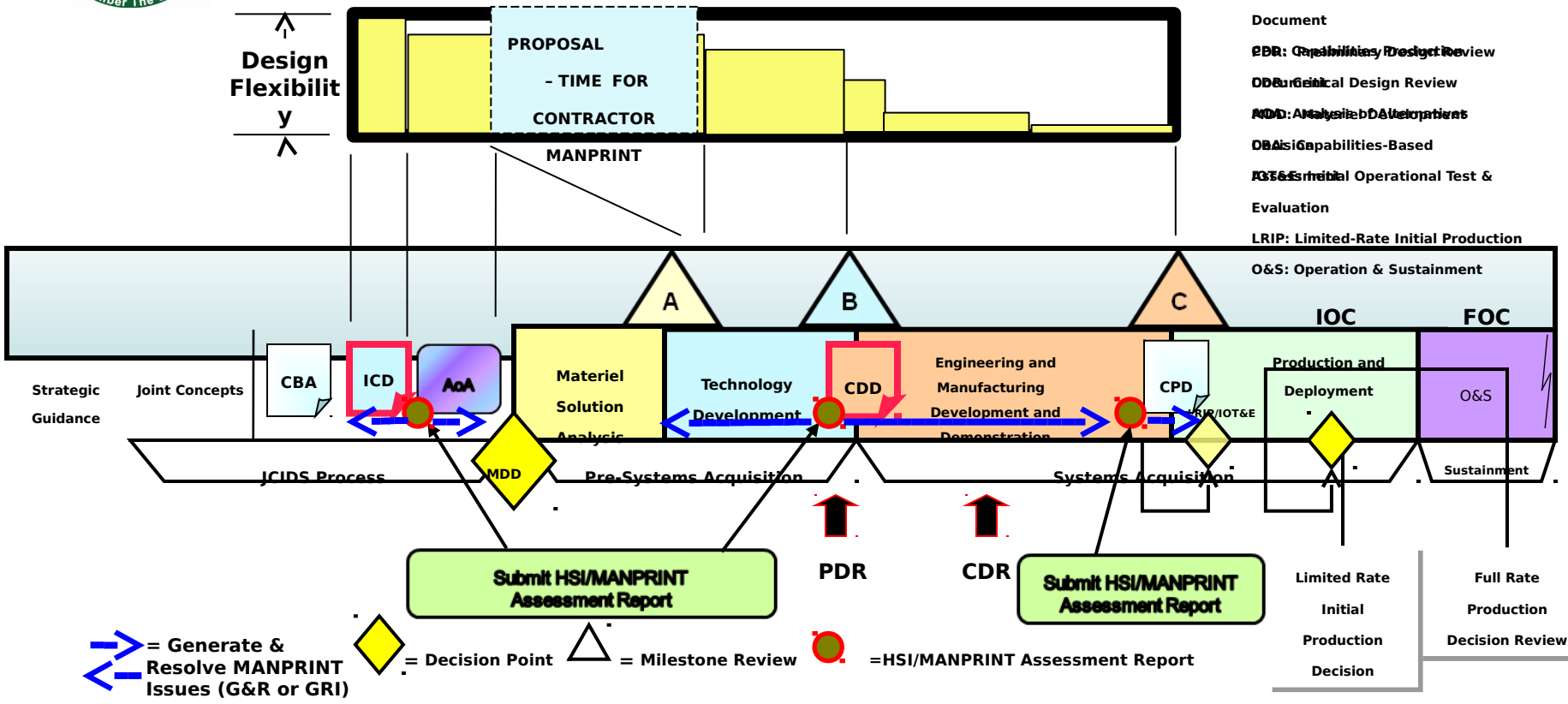
When a Design Can Be Positively Affected



Basic Slide Obtained From Briefing by Dr. Drillings of G-1 MANPRINT Directorate, modified by Mr. Zigler

Design Flexibility

The "Flexibility Window" Doesn't Stay Open



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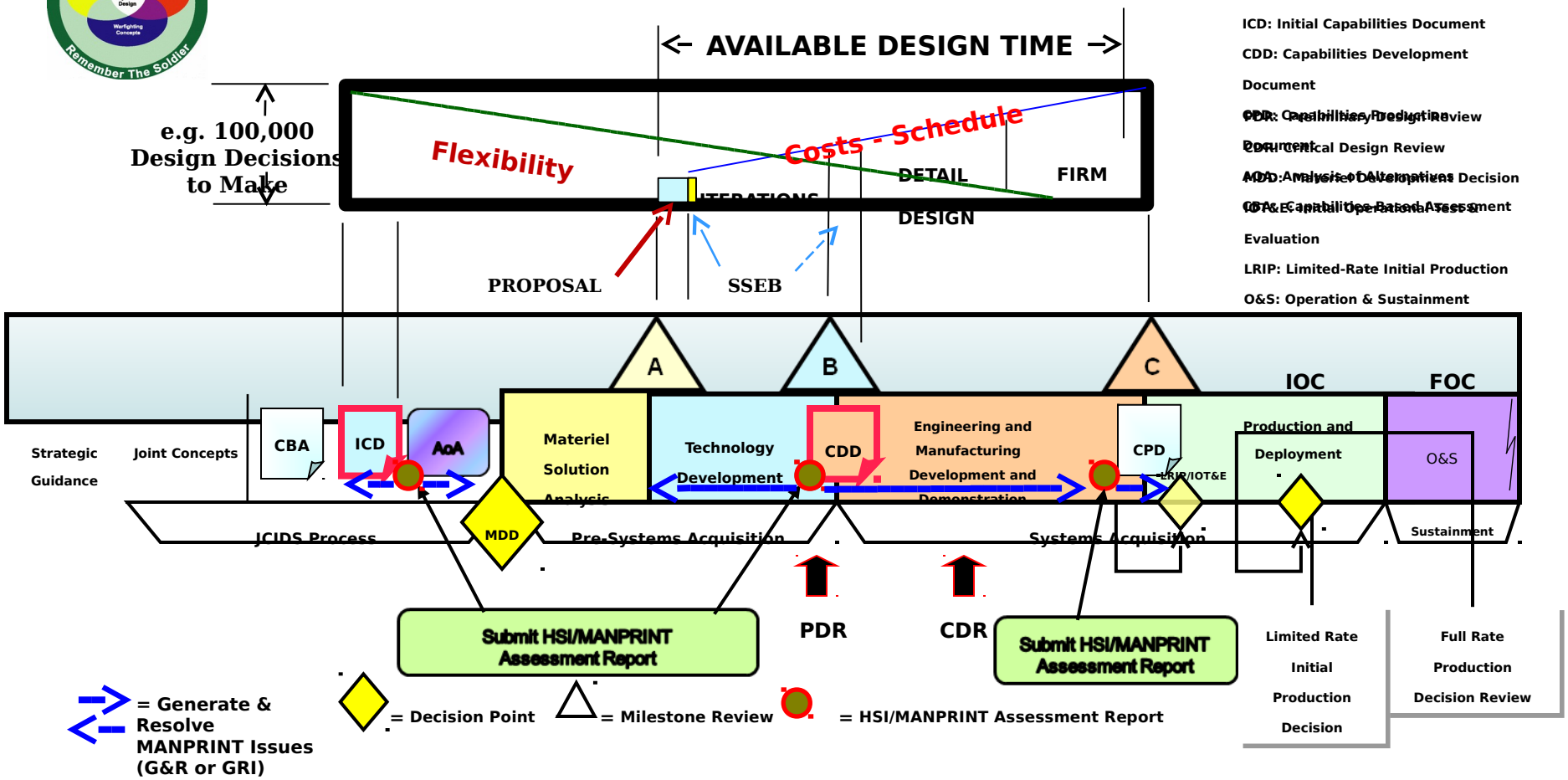
Basic Slide Obtained From Briefing by Dr. Drillings of G-1 MANPRINT Directorate, modified by Mr. Zigler

Re-Design Flexibility

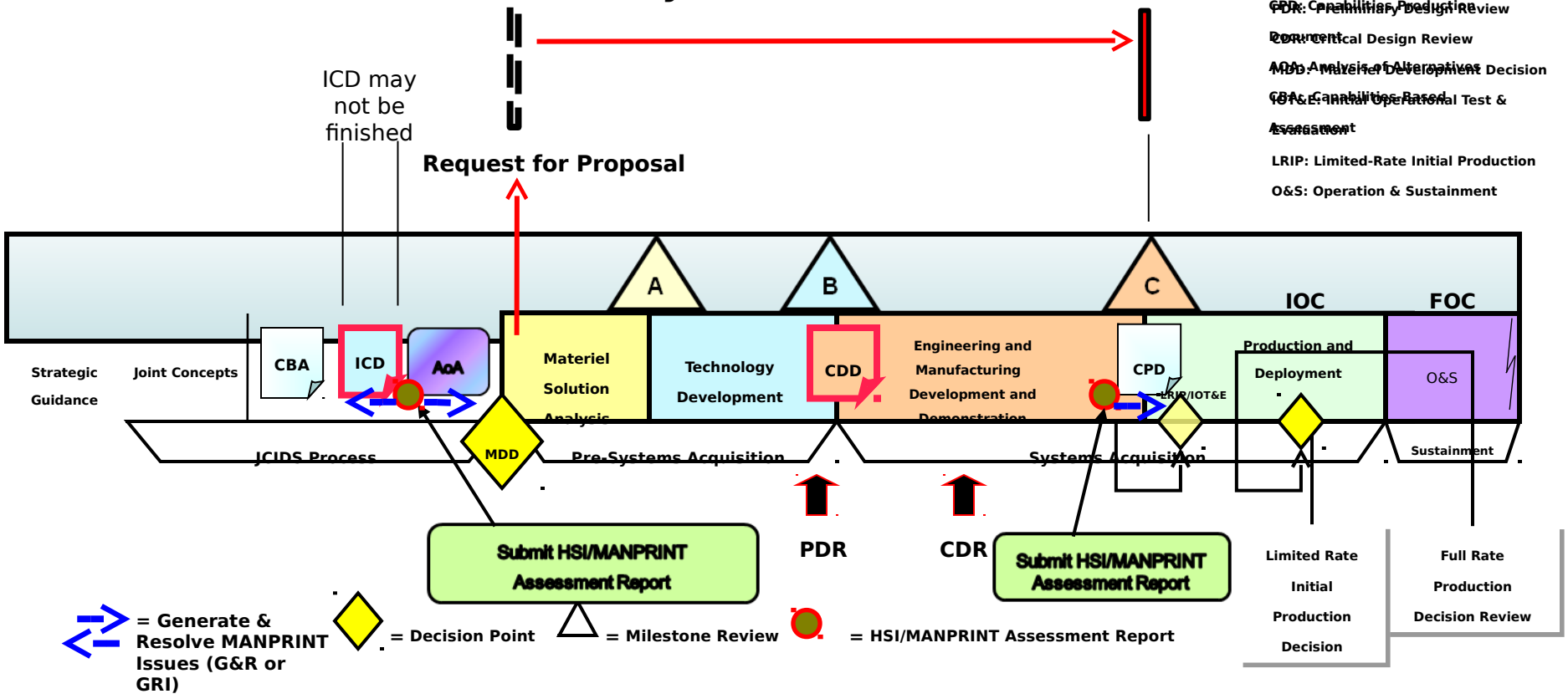
Re-Design Costs Go Up as Time Flies By



Basic Slide Obtained From Briefing by Dr. Drillings of G-1 MANPRINT Directorate, modified by Mr. Zigler

Rapid Equipping of the Force
- Design Flexibility -

The "Flexibility Window" May Exist Only at the RFP!
- Time May Be Non-Existent -



Basic Slide Obtained From Briefing by Dr. Drillings of G-1 MANPRINT Directorate, modified by Mr. Zigler

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Requirements For Milestone Decision Reviews

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Requirement	Milestone/Decision Point					
	MDD	A	B	P-CDRA	C	FRP
Acquisition Decision Memorandum[5]	X	X	X	X	X	X
Acquisition Program Baseline[5]			X		X	X
Acquisition Strategy[5] (see Page 5)			X		X	X
Acquisition Information Assurance Strategy (all IT incl NSS)		X	X		X	X
Affordability Assessment			X		X	
Alternate LF T&E Plan (programs with waiver from full-up LFT&E)[2]			X			
Analysis of Alternatives (AoA)[3,5]		X	X		X	X
AoA Study Guidance	X					
Benefit Analysis & Determination[1,8] (bundled acquisitions)			X			
Beyond LRIP Report[2] (incl MDAPs that are also MAIS)						X
Capability Development Document (CDD)[5]			X			
Capability Production Document (CPD)					X	
Clinger-Cohen Act (CCA) Compliance[5,7]		X	X		X	X
Competition Analysis[1,8] (depot-level maintenance rule)			X			
CIO Confirmation of CCA Compliance (DoD CIO for MAIS and MDAP)		X	X		X	X
Component Cost Estimate[5,9] (MAIS; optional MDAP)		X	X			X
Consideration of Technology Issues (MDAP & MAIS)		X	X		X	
Cooperative Opportunities[1]		X	X		X	
Core Logistics/Source of Repair Analysis[1,8]			X		X	
Corrosion Prevention Control Plan[1]			X		X	
Cost Analysis Requirements Description[5,9] (MDAP & MAIS)			X		X	X
Data Management Strategy[1] (MDAP, MAIS & ACAT II)		X	X		X	X
Economic Analysis (MAIS)[7] (may be combined w/AoA at MSA)		X	X			X
Exit Criteria[5]		X	X		X	X
Industrial Base Capabilities[1] (MDAPs only)		X	X		X	
Independent Cost Estimate (ICE)[5,10,15] (MDAPs only)		X	X		X	X
Independent Technology Readiness Assessment[11]			X		X	
Information Support Plan[1,5]			X	X	X	
Initial Capabilities Document (ICD)[4,5]	X	X	X		X	
Initial Operational Test & Evaluation Completed (ACAT I & II)						X
Item Unique Identification (IUID) Plan (Part of SEP)		X	X		X	
Joint Interoperability Test Certification (IT & NSS)						X
Life-Cycle Signature Support Plan[5]		X	X		X	
Life-Cycle Sustainment Plan[1]			X		X	X
LF T&E Waiver[2] (covered systems) (n/a MAIS)			X			
LF T&E Report[2] (covered systems) (n/a MAIS)						X

ICD =>

Requirement	Milestone/Decision Point					
	MDD	A	B	P-CDRA	C	FRP
LRIP Quantities MDAP & ACAT II (n/a AIS)			X			
Manpower Estimate (MDAPS only)[5]			X		X	X
Market Research		X	X			
Milestone Decision Authority (MDA) Certification (MDAPs only)[4]		X	X		X	
MDA assessment of chem, bio, rad, and nuc survivability			X		X	
Military Equipment Validation[1]					X	X
Net-Centric Data Strategy[5,12]		X	X		X	
Operational Test Agency Report of OT&E Results			X		X	X
Preliminary Design Review (PDR) Report[16]			X			
Post-Critical Design Review (CDR) Report				X		
Post Implementation Review						X
Program Protection Plan (PPP)[1]		X	X		X	
Prog Environment, Safety & Occup Health Evaluation (PESHE)[5]			X		X	X
Replaced System Sustainment Plan[5] (MDAPs only)			X			
Selected Acquisition Report (SAR)[4,13]						
Spectrum Supportability Determination[8]			X		X	
System Threat Assessment (STA) (ACAT II)[5,14]			X		X	
System Threat Assessment Report (STAR) (ACAT I)[5,6]			X		X	
Systems Engineering Plan (SEP)		X	X		X	
Technology Development Strategy (TDS)		X	X		X	
Technology Readiness Assessment (TRA)[5]			X		X	
Test & Evaluation Master Plan (TEMP)			X		X	X
Test & Evaluation Strategy (TES)		X				

[1] Part of TDS or Acquisition Strategy
[2] OSD T&E Oversight Programs
[3] MDAP: A,B,C; MAIS: A, B, FRP
[4] Milestone C if Program Initiation
[5] Program Initiation for Ships
[6] Validated by DIA for ACAT ID; AIS use DIA validated capstone info/ops Threat Assessment Decision
[7] Milestone C if equivalent to FRP
[8] Milestone C if no Milestone B
[9] MAIS whenever an economic analysis is required
[10] May be CAIG Assessment at Milestone A
[11] ACAT ID only if required by DDR&E
[12] Summarized in TDS; details in ISP
[13] SAR at program initiation; annually thereafter
[14] Validated by Component; AIS use DIA validated capstone info/ops Threat Assessment Decision
[15] MDA may request cost assessment at Milestone A
[16] If PDR is after Milestone B, MDA will conduct a post-PDR assessment review

= Item or Area of Interest

DoDI 5000.02

Tables from Defense Acquisition University "Program Managers Tool Kit", 16th Edition (Ver. 1.0), January 2011, William Parker
Internet: http://bookstore.gpo.gov/ Phone: 202-512-1800

Acquisition Category (ACAT) Rules of Thumb

ACAT I

- Max Number Documents
- Max Organizations' Involvement
- Max Number of PMO Staff
- Milestone Decision Authority: Defense Acquisition Executive or Component Acquisition Executive

ACAT II

- Lesser Number of Required Documents
- Lesser Number of Organizations' Involvement
- Lesser Number of PMO Staff
- Milestone Decision Authority: Component Acquisition Executive or Lower

ACAT III

- Small Number of Required Documents
- Small Number of Organizations' Involvement
- Small PMO or Major Subordinate Command Staff
- Milestone Decision Authority: Lower

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U.S. Army MANPRINT Soldier Survivability (SSv)

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- **ARL-SLAD:**
  - Reduce Fratricide
  - Reduce Detectability of the Soldier
  - Reduce Probability of Being Detected
  - Minimize Damage
  - Minimize Injury
- **ARL-HRED:**
  - Reduce Physical & Mental Fatigue

Acquisition Category SSv Lead Organizations

ACAT ID	= SLAD + HRED
ACAT IC	= SLAD + HRED
ACAT II	= SLAD + HRED
ACAT III	= HRED

- **Tool: Parameter Assessment List:**
  - 6 Components
  - ~200 Base assessment issues
  - Additional issues may be attached that are Design-specific
- **Ratings Assigned Based Upon:**
  - Magnitude of the impact upon the Soldier or the system
  - Probability of the deficiency occurring

TYPES OF ISSUES
MANPRINT AR 602-2

Army Regulation 602-2 Manpower and Personnel Integration (MANPRINT) in the System Acquisition Process:

Chapter 2, Section II, Para. 2-15: "The Commanding General (CG, AMC) will–

- ***d*. Through the Director, U.S. Army Research Laboratory-Survivability/Lethality Analysis Directorate (ARL-SLAD)–**
- **(1) Provide technical ((survivability/lethality/vulnerability) issues related but not limited to conventional ballistics, nuclear, biological, and chemical (NBC), NBC-contamination survivability, electronic warfare, electronic warfare vulnerability of tactical communications systems, information operations/information warfare, atmospherics/obscurants, directed energy weapons, jamming, electronic countermeasures, and personnel vulnerability) advice and assistance to ICTs and PM IPTs on Soldier Survivability (SSv) of combat systems (see AR 70-75, Survivability of Army Personnel and Materiel para 2-18d(1)).**
- **ARL-HRED: c. (7) Provide manpower, personnel capabilities, training, and Soldier survivability expertise to force modernization and/or branch proponents and IPTs on nonmajor systems.**

Key Ingredients for Success:

- Key Understanding - Customers don't buy features, they buy benefits that: 1) make sense to *them*; 2) they can understand in their own language; 3) are important to them, to their project, to their Soldiers
- Communication - Put in the time on a program: Face-to-face contacts allow the MANPRINT Practitioner to read the non-verbal signals that may account for up to 50% of the customer's message to the Practitioner (face-to-face is best initially; pay attention to body language; "out-of-sight, out-of-mind" has negative implications if one does not attend meetings)
- Ability to identify engineering design issues of many different types
- Ability to discover hidden ("less-than-obvious") design-or-concept flaw(s)?
- Influence Resolution of Issues – Ability to convince and assist contractor design team to make positive design changes
- Did you make an early impact in the design process? (Reduce costs?; Minimize any schedule impact?)
- Did Contractor(s), Designers and/or PM acknowledge the Practitioner's contributions? Verbally? Written? Award?
- Write Well – Readers with widely differing backgrounds will read and need to understand one's assessment report to support a Milestone Decision

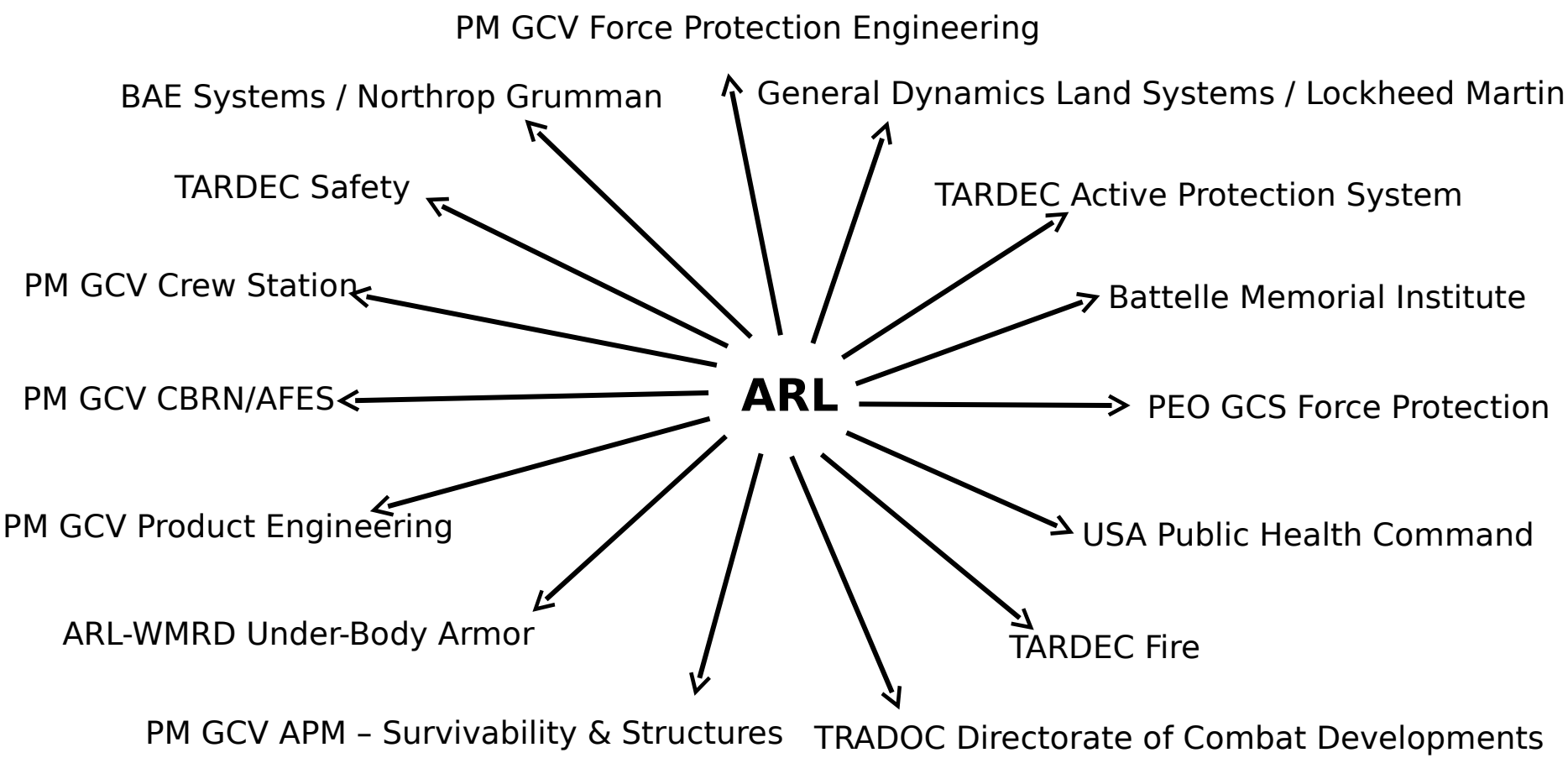
IPT's & Working Groups - SSv Areas of Interest

Example - Armored Combat Vehicle:

- Source Selection Evaluation Boards
- Structures
- Survivability (Ballistics, CBRN, EW, IW, IO, CM, Active Protection Systems)
- Turret Integration
- Lethality
- C4ISR
- Crew & Squad Volume(s)
- Stowage
- Auxiliary Systems & Locations
- Software
- Systems Integration
- Threat(s)
- Emergency Egress (Land & Water)
- Automatic Fire Extinguishing System
- Insensitive Munitions

MANPRINT SSv Collaborations Within GCV Program

*JCIDS Capabilities*SSEB's*Issue Generation & Resolution*IPT's*WG's*Assessments*CDRL Reviews*



Illustrated Examples of Potential Issues

- Design Philosophy
- Commander's Independent Weapon Station for additional defensive field-of-fire capability
- Side Escape Hatch – Hinge Location
- Access Panels Through Hull Compartment Walls
- LOAEL - Lowest Observable Adverse Effect Level
- AFES vs Elevation

Design Philosophy

"… 360 Degree Hemispheric Protection …":

- Suggested **ADAPTATION OF DESIGN CONCEPT** of armored vehicles **fighting-at-range** to now **fighting-in-cities** and in built-up areas
- Phrase written in 2000 in my paper on survivability concepts to be considered for the then-new FUTURE COMBAT SYSTEM
- Adopted by U.S. Army for FUTURE COMBAT SYSTEM
- Adopted by U.S. Army for GROUND COMBAT VEHICLE Infantry Combat Vehicle
- Contractors used this in their proposals and design(s)

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Defensive Fire

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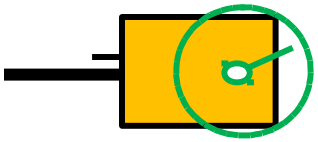
… System's ability to actively prevent or deter attack.



http://www.strategypage.com/dls/articles/20030912.asp

Unclassified After Action Report From Iraq
September 12, 2003

Issue: *Lack of a Bradley CDR (commander) weapon system.*

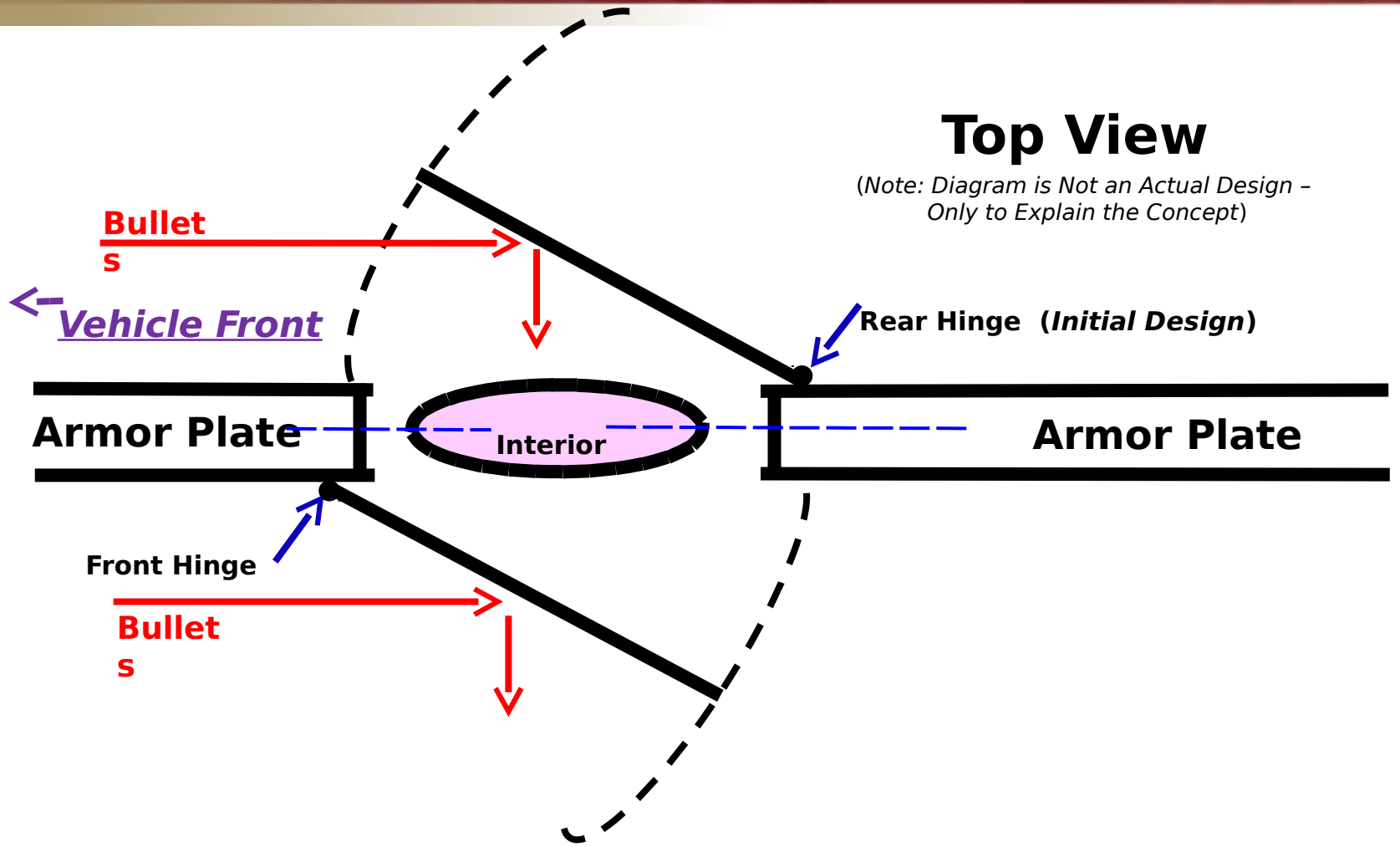
Discussion: *During the conduct of urban operations by this unit, due to limited visibility within the turret and the* ***threat encountered not only from the front but from both flanks*** *of the vehicles, Bradley commanders (BC) were* ***required to expose themselves outside of the turret*** in order to acquire enemy forces, to control movement, and protect their own vehicles. *…..*

- *TM C/3-15 Infantry, Task Force 1-64 Armor "Desert Rogues" during "Operation Iraqi Freedom"*

Mitigation of Issue for GROUND COMBAT VEHICLE:

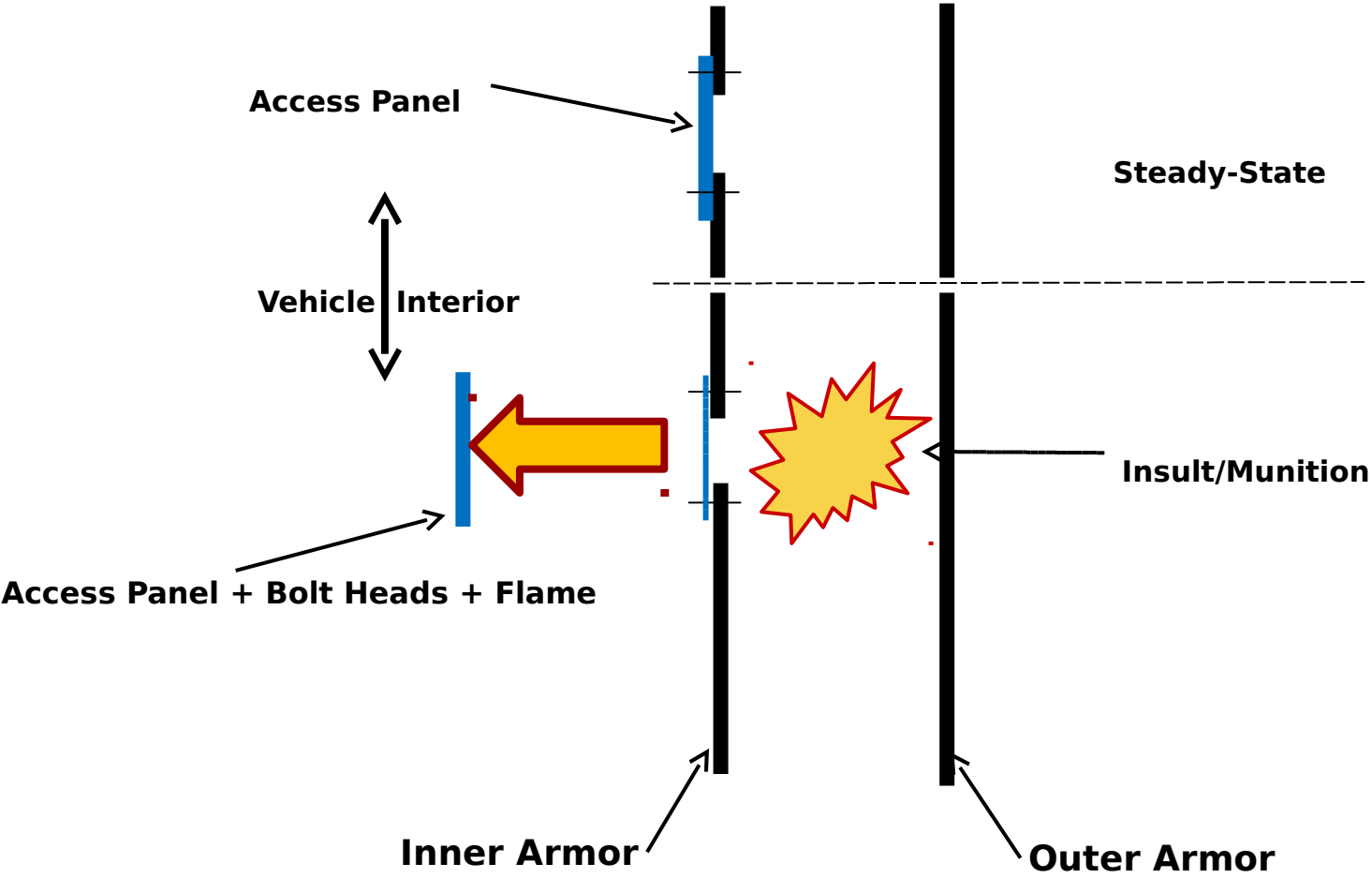
- **"Socialized"** the issue via MANPRINT Assessments and ARL-SLAD Qualitative Vulnerability Assessment briefings (FUTURE COMBAT SYSTEM)
- **"Proposed a Capability with Rationale"** via GROUND COMBAT VEHICLE JCIDS Process for the **Initial Capabilities Document** with USA TRADOC and ARL-HRED's Cheryl Burns, who was working directly with TRADOC Writers.
- **Up to 180 degree fire from primary weapon accepted into ICD**
- TRADOC Capabilities Manager (ICD), Program Manager's Office (PSPEC/ASPEC), and Contractors (Designs) **Devised and Implemented a Solution(s).**

Hinge Location – Side Escape Hatch



Location of Access Panels

Less-Than-Obvious Issue:



AFES' FM-200: % Concentration in Interior

For FM-200 (HFC-227ea) Lowest Observable Adverse Effect Level (LOAEL) is >10.5%

for Cardiac Sensitization.

IV.1.f. Does the system prevent or protect the crew from toxic gases from fires?

The No Observable Adverse Effect Level (NOAEL) is 9.0%

(1) Platform includes an automatic fire extinguishing system that will help prevent the generation of fire and the resulting toxic gasses. AFES system will use FM-200 (1,1,1,2,3,3,3-Heptafluoropropane) with small quantities of sodium bicarbonate, a scavenging agent which will reduce the levels of hydrogen fluoride (HF) formed when extinguishing a Class B fire.

[NOTE: *FM-200 decomposes under elevated temperatures, producing hydrogen fluoride, carbonyl fluoride, carbon monoxide and carbon dioxide.*]

According to the National Fire Protection Association (NFPA) for HFC-227ea (FM-200), the exposure limits are:

Concentration (%volume/volume)	Max Exposure Time (minutes)
Up to 10.5	5
11	1.13
11.5	0.60
12	0.49

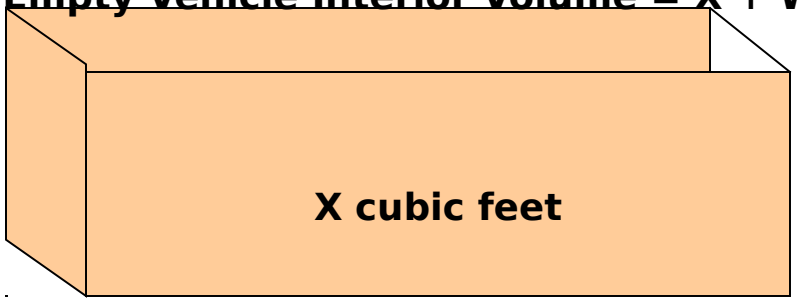
(NO FIRE)

Mitigation: Be alert on calculations & estimates to include volumes of troops & gear.

AFES' Concern: % Concentration?

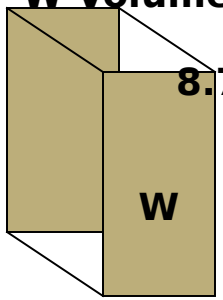
s-Than-Obvious Issue: Subtract Volumes of Soldiers & Equipment

Empty Vehicle Interior Volume = X + W



W Volume of FM-200 =

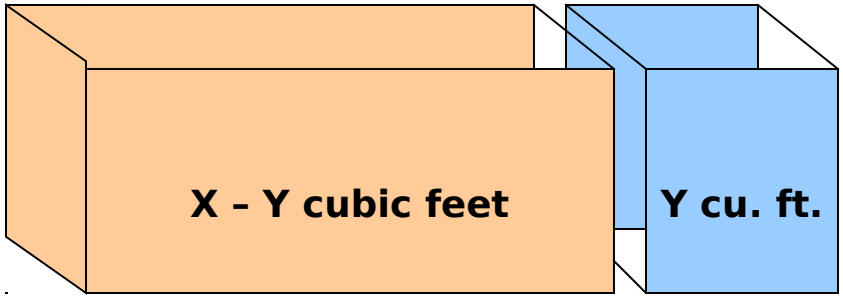
8.7% of Interior Volume

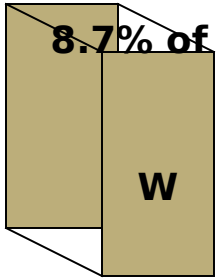


X + W = 8.7% vol/vol (concentration)

W Volume of FM-200 =

8.7% of Interior Volume



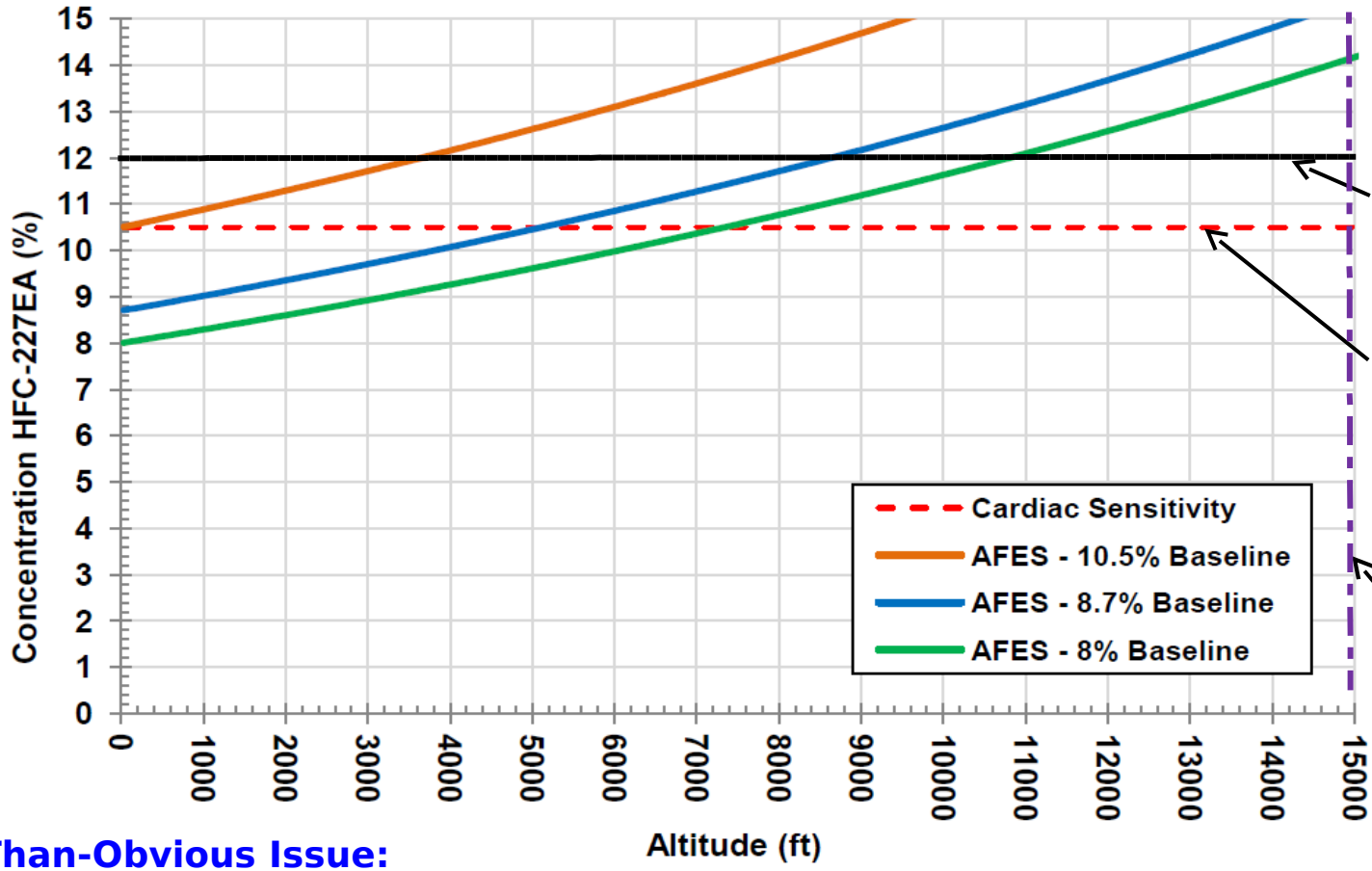


(X-Y) + W = ?% vol/vol

Volume of Soldiers + Equipment = Y

FM-200 fire suppressant tuned to 8.7% concentration with empty vehicle & open hatches. (No fire.) (Halon 1301 is tuned to 7% concentration.)

Change OF AFES HFC-227EA Concentrations Versus Altitude



Less-Than-Obvious Issue: Heavier-than-air => concentration settles toward floor (dazed? wounded?)

Temperature is held constant at 68°F.

The change of HFC-227EA concentrations as a function of altitude, if the AFES is designed to operate at 68 °F and at sea level. Chart is still unofficial at this time.

Contributed by M. Kaufman. This figure is based on the guidance provided in *Design Manual, HFC-227ea Extinguishing System*, Bettati Fire Technology, Reggio Emilia, Italy, 3 August 2007.

Additional Examples of Potential SSv Issues

- **Castings** – voids
- **Hatch-opening design** – hand-crank time to open
- **Emergency egress (land & water)** – 1) minimally impeded; 2) spatial disorientation to have little effect; 3) breathing capability in vehicle; and 4) ability to open hatches when submerged (*few of the pointers provided for US Naval Postgraduate School student thesis*)
- **Air Bottles for submerged emergency egress (capability)** - bottles for egress
- **Soldier O2 vs Elevation**
- **Many others not discussed** – *proprietary and/or classified*

Important HSI/MANPRINT Features

Important Features of HSI/MANPRINT:

- **Timeliness – issue generation; issue resolution**
- **Positively-influencing - design & design changes**
- **System Integration - Exceptional width of issue coverage**